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**TECHNICAL MEMORANDUM**

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Date:  
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Subject:  
Derivation of Preliminary Risk-Based Concentrations for the  
California Clapper Rail for PCBs – Yosemite Slough

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This technical memorandum, prepared by ARCADIS, presents the rationale and back-calculation of risk-based concentrations (RBCs) for polychlorinated biphenyls (PCBs) applicable to sediment at Yosemite Slough (the Site) for the protection of California clapper rail (CCR; *Rallus longirostris obsoletus*). CCR are not currently found at the Site. However, due to the California State Parks restoration effort around the slough, it has been suggested that suitable foraging and nesting habitat for the CCR may be created. As such, site-specific RBCs for PCBs protective of CCRs were derived in this memorandum to assess whether current cleanup goals will also be protective of CCR.

## **Background**

Remediation goals for PCBs were provided in the Hunters Point Shipyard (HPS) Parcel F Feasibility Study (Barajas & Associates, Inc. 2008) based on site-specific studies provided in the *Final HPS Parcel F Validation Study* (Battelle, BBL, and Neptune & Co. 2005) and other considerations. The proposed remediation goals for Parcel F include:

- A not-to-exceed value of 1.24 mg/kg, based on the protection of the surf scoter using a site use factor (SUF<sup>1</sup>) of 0.5; and
- An area-weighted average (AWA) of 0.386 mg/kg, which was simply the calculated, theoretical post-remedial AWA following removal of all sediments with over 1.24 mg/kg of PCBs within Parcel F. This value is not ecologically based but rather corresponds to a post-remedial excess lifetime cancer risk of 3E-06 for human health receptors.

The approach used to calculate the remedial goals at HPS described above is somewhat unusual. More typically, ecological remedial goals based on foraging species such as the surf scoter will be calculated and applied as an AWA since these types of receptors are exposed across their foraging areas and not on a point-by-point basis. At HPS, the approach used for calculating risk for the surf scoter as a NTE level assumes exposure on a point-by-point basis and is thus more conservative than calculating risk based on an AWA. As noted above, the AWA value calculated for HPS is not an ecologically-based value, but a post-remedial concentration based on human health risk.

The remediation goals from HPS listed above have been adopted at Yosemite Slough. This memorandum calculates RBCs for the CCR and compares those to the remediation goals listed above to assess the protectiveness of these goals.

### California Clapper Rail

The CCR is listed as endangered under both the State of California and Federal Endangered Species Acts (LSA Associates, Inc. 2009). In saline emergent wetlands, CCRs nest mostly in lower zones near tidal sloughs and where cordgrass (*Spartina foliosa*) is abundant. They prefer tall stands of pickleweed (*Salicornia virginica*) and Pacific cordgrass but are also associated with gumplant (*Grindelia* spp.), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia grandifolia*), and jaumea (*Jaumea carnosa*) in high marshes. CCR prefers habitats containing marshes supporting tidal sloughs that provide direct tidal circulation throughout the area. They also require shallow water and mudflats with sparse vegetation and abundant invertebrate populations for foraging habitat, and escape routes from predators (Zemba and Massey 1983, Foerster *et al.* 1990, as cited by LSA Associates, Inc. 2009). Thus, future habitat in restored areas around and within some portions of Yosemite Slough may provide habitat for the endangered CCR.

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<sup>1</sup> The site use factor (SUF) is an estimate of the amount of time the receptor is expected to utilize the site. The SUF should consider exposure parameters such as the receptor's home range, foraging range, size of the site, and/or possibility of migration. Available habitat for the receptor should also be considered.

## RBC Calculation

To evaluate whether post-remedial exposure concentrations of PCBs in associated mudflats would be protective of CCR, RBCs were calculated by re-arranging the standard U.S. Environmental Protection Agency (USEPA 1997) risk model to solve for no-effect and lowest-effect target hazard quotients (HQs) of 1, which are considered to be protective of ecological receptors including the CCR. The model used to solve for RBCs is as follows:

$$HQ = \frac{Dose}{TRV}$$

Where:

$$Dose = \frac{\{C_{sed} \times IR_{sed} \times [IR_{food} \times [(BAF_{invert} \times \%diet) + (BAF_{plant} \times \%diet)]] \times SUF}{BW}$$

The equation is rearranged to solve for  $C_{sed}$ , such that:

$$RBC = C_{sed} = \frac{TRV \times BW \times HQ}{SUF \times \{IR_{sed} + [IR_{food} \times [(BAF_{invert} \times \%diet) + (BAF_{plant} \times \%diet)]]\}}$$

Where:

RBC	=	risk-based concentration
$C_{sed}$	=	concentration in sediment (milligrams per kilogram)
SUF	=	site use factor (unitless)
TRV	=	toxicity reference value (milligrams per kilogram of body weight per day)
BW	=	body weight (kilograms)
$IR_{sed}$	=	ingestion rate of sediment (kilograms per day, dry weight)
$IR_{food}$	=	ingestion rate of food (kilograms per day, dry weight)
$BAF_{invert}$	=	sediment-to-invertebrate bioaccumulation factor in dry weight (unitless)
$BAF_{plant}$	=	sediment-to-plant bioaccumulation factor in dry weight (unitless)
% diet	=	percent of receptor's diet
HQ	=	hazard quotient; set to 1 to back-calculate the RBC

Exposure factors for CCR, used as inputs to the above equation, were obtained from California's Office of Environmental Health Hazard Assessment (OEHHA) and Department of Toxic Substances Control (DTSC), as appropriate. Supplemental values for food ingestion were calculated based on allometric ingestion rate equations presented by Nagy (2001). Sediment ingestion rates were estimated on a dry weight basis, using the least sandpiper as a surrogate for the CCR, which has similar foraging habits, obtained from Beyer et al. (1994). Exposure factors and their derivation/basis are provided in Table 1.

CCR forage in higher marsh vegetation, along the vegetation and mudflat interface, and along tidal creeks. They feed by gleaning, pecking, probing, and scavenging from the surface (Harvey 1990). Along the coast, CCR prey on crabs, mussels, clams, snails, insects, spiders, and worms (Harvey 1990). In a study by Moffitt (1941), the volumetric content of CCR stomachs averaged more than 85 percent (%) animal matter and 14.5% vegetable matter. Therefore, for the RBC calculations, the CCR's diet was assumed to consist of 85% invertebrates and 15% plants.

To estimate the potential concentration of PCBs in food items, bioaccumulation factors (BAFs) were incorporated into the above equation. BAFs were multiplied by the sediment concentration to provide an estimate of predicted tissue concentration. The sediment-to-invertebrate BAF for PCBs was based on the BAF calculated for the South Basin (Area X) of Hunters Point Shipyard (HPS) from the *Final HPS Parcel F Validation Study* (Battelle, BBL, and Neptune & Co. 2005). For that study, laboratory-exposed *Macoma nasuta* tissue and sediment PCB concentrations from the study area were evaluated to develop a ratio representative of the potential uptake of PCBs into *M. nasuta* tissue. That BAF value of 2 was utilized in the development of remedial goals for the HPS site (Barajas & Associates, Inc. 2008). Due to the similarity and proximity of the Site, a BAF<sub>invert</sub> value of 2 was also selected for the RBC calculation for the CCR.

The sediment-to-plant BAF was developed based on the regression equation presented in Travis and Arms (1988) for the estimation of uptake of organic constituents into vegetation:

$$\text{Log BAF}_{\text{vegetation}} = 1.588 - 0.578 \log K_{ow}$$

The Travis and Arms model utilizes the log value of each constituent's bioaccumulation potential (i.e., the octanol-water partition coefficient [ $K_{ow}$ ]) to predict uptake. BAF<sub>plant</sub> was developed using log  $K_{ow}$  for seven individual Aroclors, and the average BAF (0.033) for all Aroclors was selected for the RBC calculation for the CCR.

For the SUF, the area of potentially exposed mudflat and future available habitat along the perimeter of the slough was estimated to be approximately 10 acres. This is based on estimated measurements of the area of the slough, which equal approximately 10 acres. This value was divided by the clapper rail's home range, which is approximately 31 acres, based on mean available data for clapper rails in Arizona (Conway et al. 1993). Thus, a SUF of 0.3 is considered to be a relatively conservative value for the mudflat/exposed area of the slough and given that wetland habitats planned to be created on State Parks land will likely be higher quality and more suitable foraging habitat. To provide a range of potential RBCs utilizing a range of SUFs to bound this value, RBCs were calculated for SUFs ranging from 0.01 to 1 (Tables 2 and 3).

Toxicity reference values (TRVs) are literature-based values of concentrations of chemicals that have known toxicological effects on an organism. They can be based on no observed adverse effects level (NOAEL) or lowest observed adverse effects level (LOAEL). TRVs were selected for birds from the

USEPA's Region 9 Biological Technical Assistance Group (BTAG) (DTSC 2009). Sample and Arenal (1999) recommend scaling the TRV based on the target receptor's body weight. This was done at the HPS site for the Validation Study (Battelle, BBL, and Neptune & Co. 2005), although DTSC does not currently recommend incorporating allometric scaling of TRVs for receptors that differ in body weight from the test species by less than two orders of magnitude (DTSC 1999) and USEPA generally does not recommend scaling of TRVs.

An automated, iterative calculation algorithm was used to combine the dose equation and uptake factors into a single forward calculation by using Microsoft® Goal Seek™, an add-on to Microsoft® Excel that finds a solution by iterative trial-and-error that satisfies calculation constraints introduced by having interdependent mathematical equations. To present a range of potential RBCs, the values were calculated using TRVs scaled to clapper rail body weight (Table 2) and unscaled TRVs (Table 3) and for a range of SUFs. RBCs are also presented for both low and high TRVs;  $TRV_{low}$  is based on the NOAEL and  $TRV_{high}$  is based on the LOAEL. The selected RBC is conservatively based on  $TRV_{low}$  to ensure protection of the most sensitive organisms. Shaded rows in Tables 2 and 3 present the recommended RBCs based on a SUF of 0.3 (1.41 milligrams per kilogram [mg/kg] based on the scaled  $TRV_{low}$  and 1.75 mg/kg based on the unscaled  $TRV_{low}$ ).

To compare this assessment with other ecological risk assessments in the region, the RBC derivation was also conducted using the general exposure parameters from the Hamilton Army Airfield (HAA), Base Realignment and Closure (BRAC) Property Human Health and Ecological Risk Assessment (HHERA) (U.S. Army 2001). These included a slightly larger body weight of 0.39 kg (as opposed to 0.271 kg), a dietary composition consisting of 100% benthic invertebrates (as opposed to 85% invertebrates and 15% plants), a higher sediment ingestion rate of 18% (as opposed to 7.3%), and a slightly higher food ingestion rate (based on elevated body weights) as shown in Table 4. The model was run again both with TRVs scaled for the revised body weight and with unscaled TRVs using the general exposure parameters from the HAA site but the site-specific parameters such as the BAF and SUF from the Site were used. Resulting RBCs (referred below as HAA Assumptions-based RBCs) are similar to the recommended RBCs for the Site (Tables 5 and 6).

The table below presents a summary of the RBCs based on the SUF of 0.3 at the Site, using scaled and unscaled TRVs for the two different sets of exposure parameters.

	Recommended RBCs (mg/kg) (SUF = 0.3)		HAA Assumptions-based RBCs (mg/kg) (SUF = 0.3)	
	RBC <sub>low</sub>	RBC <sub>high</sub>	RBC <sub>low</sub>	RBC <sub>high</sub>
Scaled TRVs	1.41	17.09	1.42	17.09
Unscaled TRVs	1.75	24.73	1.64	23.11

Under the most conservative scenario, the table below presents a summary of the RBCs based on the SUF of 1 at the Site, using scaled and unscaled TRVs for the two different sets of exposure parameters.

	Conservative RBCs (mg/kg) (for SUF = 1)		HAA Assumptions-based RBCs (mg/kg) (SUF =1)	
	RBC <sub>low</sub>	RBC <sub>high</sub>	RBC <sub>low</sub>	RBC <sub>high</sub>
Scaled TRVs	0.42	5.13	0.43	5.13
Unscaled TRVs	0.53	7.42	0.49	6.93

## Conclusions

The currently recommended remediation goals at Yosemite Slough are based on the remediation goals from HPS. At HPS, the ecological remediation goals for the surf scoter were developed using a SUF of 0.5 and a NOAEL-based TRV<sup>2</sup> and resulted in an NTE value of 1.24 mg/kg. The recommended site-specific RBCs calculated in this memorandum (i.e., based on a SUF of 0.3 and BAF = 2 for PCBs) protective of CCR range from 1.41 mg/kg based on the scaled NOAEL-based TRV to 24.73 mg/kg based on the unscaled LOAEL-based TRV. Therefore, because these RBCs are higher than the NTE value of 1.24 mg/kg, the current remediation goals for Yosemite Slough are protective of the CCR.

Moreover, as discussed above, an AWA remediation goal of 0.386 mg/kg was also calculated for HPS, but this value was not ecologically based. Normally, the value calculated as 1.24 mg/kg would be applied as an average within the exposure area and not as a NTE level because foraging species like the surf scoter and CCR are exposed across their foraging areas and not on a point-by-point basis. Therefore, the use of the remediation goal as a NTE value is conservative and protective.

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<sup>2</sup> LOAEL-based TRVs are generally used for non-special status species such as surf scoter and NOAEL-based TRVs are generally used for special status species. Therefore, the assessment at HPS was more conservative than that for other sites.

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## Attachments

Table 1	Exposure Parameters for the California Clapper Rail
Table 2a	NOAEL-Based RBCs for California Clapper Rail – PCBs (scaled TRVs)
Table 2b	LOAEL-Based RBCs for California Clapper Rail – PCBs (scaled TRVs)
Table 3a	NOAEL-Based RBCs for California Clapper Rail – PCBs (unscaled TRVs)
Table 3b	LOAEL-Based RBCs for California Clapper Rail – PCBs (unscaled TRVs)
Table 4	Exposure Parameters for the California Clapper Rail from HAA
Table 5a	NOAEL-Based RBCs for California Clapper Rail – PCBs (scaled TRVs and HAA Exposure Parameters)
Table 5a	LOAEL-Based RBCs for California Clapper Rail – PCBs (scaled TRVs and HAA Exposure Parameters)
Table 6a	NOAEL-Based RBCs for California Clapper Rail – PCBs (unscaled TRVs and HAA Exposure Parameters)
Table 6b	LOAEL-Based RBCs for California Clapper Rail – PCBs (unscaled TRVs and HAA Exposure Parameters)

**Table 1. Exposure Parameters for the California Clapper Rail (*Rallus longirostris obsoletus*)**

Parameter	Symbol	Value	Unit	Reference
Food Ingestion Rate	$IR_{\text{food}}$	0.026	kg/day (dw)	Calculated using body weight of 271 g with equation for food requirement for intake for omnivorous birds (Nagy 2001): $[[0.67*(BW)]^{0.627}]/1000$
Sediment Ingestion Rate	$IR_{\text{sed}}$	0.0019	kg/day (dw)	7.3% of food ingestion rate; based on value for least sandpiper (Beyer et al. 1994)
Sediment-to-Invertebrate Bioaccumulation Factor	$BAF_{\text{invert}}$	2	unitless	Calculated for PCBs in Area X (South Basin) at Hunters Point Shipyard (Battelle, BBL, and Neptune & Co. 2005)
Sediment-to-Plant Bioaccumulation Factor	$BAF_{\text{plant}}$	0.033	unitless	Calculated using Travis and Arms (1988) log $K_{ow}$ equation for 7 individual Aroclors and averaged: $\text{Log } BAF_{\text{vegetation}} = 1.588 - 0.578 \text{ log } K_{ow}$ . Log $K_{ow}$ values obtained from EPI (USEPA 2011)
Dietary Composition	% diet	85%	invertebrates	From Moffitt (1941) for the California clapper rail as referenced in OEHHA (2012)
		15%	plants	
Home Range	-	31	acres	Mean home range of the clapper rail in Arizona during breeding season (Conway et al. 1993) as referenced by OEHHA (2012)
Site Use Factor	SUF	0.3	unitless	Assumes entire slough area is used for foraging ~10 acres
Body Weight	BW	0.271	kg	Mean values for the clapper rail from (Hammons et al. 1988) as referenced in OEHHA (2012)
Toxicity Reference Value - low	$TRV_{\text{low}}$	0.09	mg/kg/day	From Platonow & Reinhart (1973) as referenced by Region 9 BTAG (DTSC 2009); based on chicken (BW = 0.8 kg)
Toxicity Reference Value - high	$TRV_{\text{high}}$	1.27	mg/kg/day	From Britton & Huston (1973) as referenced by Region 9 BTAG (DTSC 2009); based on chicken (BW = 1.72 kg)
Body Weight Adjusted TRV - low	Adjusted $TRV_{\text{low}}$	0.07	mg/kg/day	Body-weight adjusted TRV (Sample and Arenal 1999)
Body Weight Adjusted TRV - high	Adjusted $TRV_{\text{high}}$	0.878	mg/kg/day	

**Abbreviations:**

kg = kilograms  
 kg/day = kilograms per day  
 dw = dry weight  
 g = gram  
 mg/kg/day = milligrams per kilogram per day  
 BW = body weight  
 IR = ingestion rate  
 BAF = bioaccumulation factor  
 SUF = site use factor  
 PCB = polychlorinated biphenyls  
 TRV = toxicity reference value

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**Table 2a. NOAEL-Based RBCs for California Clapper Rail - PCBs (scaled TRVs)**

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				NOAEL	NOAEL	
0.271	1	0.033	2	15%	85%	0.014	0.849	0.0261	0.0019	0.07	0.07	0.42	1.00
0.271	0.9	0.033	2	15%	85%	0.016	0.941	0.0261	0.0019	0.07	0.07	0.47	1.00
0.271	0.8	0.033	2	15%	85%	0.017	1.059	0.0261	0.0019	0.07	0.07	0.53	1.00
0.271	0.7	0.033	2	15%	85%	0.020	1.210	0.0261	0.0019	0.07	0.07	0.60	1.00
0.271	0.6	0.033	2	15%	85%	0.023	1.412	0.0261	0.0019	0.07	0.07	0.71	1.00
0.271	0.5	0.033	2	15%	85%	0.028	1.694	0.0261	0.0019	0.07	0.07	0.85	1.00
0.271	0.4	0.033	2	15%	85%	0.035	2.117	0.0261	0.0019	0.07	0.07	1.06	1.00
0.271	0.3	0.033	2	15%	85%	0.047	2.823	0.0261	0.0019	0.07	0.07	1.41	1.00
0.271	0.2	0.033	2	15%	85%	0.070	4.235	0.0261	0.0019	0.07	0.07	2.12	1.00
0.271	0.1	0.033	2	15%	85%	0.140	8.470	0.0261	0.0019	0.07	0.07	4.23	1.00
0.271	0.05	0.033	2	15%	85%	0.280	16.940	0.0261	0.0019	0.07	0.07	8.47	1.00
0.271	0.02	0.033	2	15%	85%	0.699	42.349	0.0261	0.0019	0.07	0.07	21.17	1.00
0.271	0.01	0.033	2	15%	85%	1.398	84.699	0.0261	0.0019	0.07	0.07	42.35	1.00

**Table 2b. LOAEL-Based RBCs for California Clapper Rail - PCBs (scaled TRVs)**

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				LOAEL	LOAEL	
0.271	1	0.033	2	15%	85%	0.169	10.3	0.0261	0.0019	0.88	0.878	5.13	1.00
0.271	0.9	0.033	2	15%	85%	0.188	11.4	0.0261	0.0019	0.88	0.878	5.70	1.00
0.271	0.8	0.033	2	15%	85%	0.212	12.8	0.0261	0.0019	0.88	0.878	6.41	1.00
0.271	0.7	0.033	2	15%	85%	0.242	14.7	0.0261	0.0019	0.88	0.878	7.33	1.00
0.271	0.6	0.033	2	15%	85%	0.282	17.1	0.0261	0.0019	0.88	0.878	8.55	1.00
0.271	0.5	0.033	2	15%	85%	0.338	20.5	0.0261	0.0019	0.88	0.878	10.26	1.00
0.271	0.4	0.033	2	15%	85%	0.423	25.6	0.0261	0.0019	0.88	0.878	12.82	1.00
0.271	0.3	0.033	2	15%	85%	0.564	34.2	0.0261	0.0019	0.88	0.878	17.09	1.00
0.271	0.2	0.033	2	15%	85%	0.846	51.3	0.0261	0.0019	0.88	0.878	25.64	1.00
0.271	0.1	0.033	2	15%	85%	1.692	102.6	0.0261	0.0019	0.88	0.878	51.28	1.00
0.271	0.05	0.033	2	15%	85%	3.384	205.1	0.0261	0.0019	0.88	0.878	102.55	1.00
0.271	0.02	0.033	2	15%	85%	8.461	512.8	0.0261	0.0019	0.88	0.878	256.38	1.00
0.271	0.01	0.033	2	15%	85%	16.921	1025.5	0.0261	0.0019	0.88	0.878	512.77	1.00

**Notes:**

Following inputs to the dietary dose model and the TRV, goal seek was used to calculate a RBC based on an HQ of 1.

shaded row indicates recommended values for Yosemite Slough.

**Abbreviations:**

kg = kilograms

kg/day = kilograms per day

dw = dry weight

mg/kg/day = milligrams per kilogram per day

BAF = bioaccumulation factor

SUF = site use factor

TRV = toxicity reference value

NOAEL = no observed adverse effect level

LOAEL = lowest observed adverse effect level

HQ = hazard quotient

PCB = polychlorinated biphenyls

RBC = risk-based concentration

**Table 3a. NOAEL-Based RBCs for California Clapper Rail - PCBs (unscaled TRVs)**

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				NOAEL	NOAEL	
0.271	1	0.033	2	15%	85%	0.017	1.052	0.0261	0.0019	0.09	0.09	0.53	1.00
0.271	0.9	0.033	2	15%	85%	0.019	1.169	0.0261	0.0019	0.09	0.09	0.58	1.00
0.271	0.8	0.033	2	15%	85%	0.022	1.315	0.0261	0.0019	0.09	0.09	0.66	1.00
0.271	0.7	0.033	2	15%	85%	0.025	1.502	0.0261	0.0019	0.09	0.09	0.75	1.00
0.271	0.6	0.033	2	15%	85%	0.029	1.753	0.0261	0.0019	0.09	0.09	0.88	1.00
0.271	0.5	0.033	2	15%	85%	0.035	2.103	0.0261	0.0019	0.09	0.09	1.05	1.00
0.271	0.4	0.033	2	15%	85%	0.043	2.629	0.0261	0.0019	0.09	0.09	1.31	1.00
0.271	0.3	0.033	2	15%	85%	0.058	3.506	0.0261	0.0019	0.09	0.09	1.75	1.00
0.271	0.2	0.033	2	15%	85%	0.087	5.259	0.0261	0.0019	0.09	0.09	2.63	1.00
0.271	0.1	0.033	2	15%	85%	0.174	10.517	0.0261	0.0019	0.09	0.09	5.26	1.00
0.271	0.05	0.033	2	15%	85%	0.347	21.034	0.0261	0.0019	0.09	0.09	10.52	1.00
0.271	0.02	0.033	2	15%	85%	0.868	52.586	0.0261	0.0019	0.09	0.09	26.29	1.00
0.271	0.01	0.033	2	15%	85%	1.735	105.172	0.0261	0.0019	0.09	0.09	52.59	1.00

**Table 3b. LOAEL-Based RBCs for California Clapper Rail - PCBs (unscaled TRVs)**

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				LOAEL	LOAEL	
0.271	1	0.033	2	15%	85%	0.245	14.8	0.0261	0.0019	1.27	1.27	7.42	1.00
0.271	0.9	0.033	2	15%	85%	0.272	16.5	0.0261	0.0019	1.27	1.27	8.24	1.00
0.271	0.8	0.033	2	15%	85%	0.306	18.6	0.0261	0.0019	1.27	1.27	9.28	1.00
0.271	0.7	0.033	2	15%	85%	0.350	21.2	0.0261	0.0019	1.27	1.27	10.60	1.00
0.271	0.6	0.033	2	15%	85%	0.408	24.7	0.0261	0.0019	1.27	1.27	12.37	1.00
0.271	0.5	0.033	2	15%	85%	0.490	29.7	0.0261	0.0019	1.27	1.27	14.84	1.00
0.271	0.4	0.033	2	15%	85%	0.612	37.1	0.0261	0.0019	1.27	1.27	18.55	1.00
0.271	0.3	0.033	2	15%	85%	0.816	49.5	0.0261	0.0019	1.27	1.27	24.73	1.00
0.271	0.2	0.033	2	15%	85%	1.224	74.2	0.0261	0.0019	1.27	1.27	37.10	1.00
0.271	0.1	0.033	2	15%	85%	2.449	148.4	0.0261	0.0019	1.27	1.27	74.20	1.00
0.271	0.05	0.033	2	15%	85%	4.898	296.8	0.0261	0.0019	1.27	1.27	148.41	1.00
0.271	0.02	0.033	2	15%	85%	12.244	742.0	0.0261	0.0019	1.27	1.27	371.02	1.00
0.271	0.01	0.033	2	15%	85%	24.488	1484.1	0.0261	0.0019	1.27	1.27	742.05	1.00

**Notes:**

Following inputs to the dietary dose model and the TRV, goal seek was used to calculate a RBC based on an HQ of 1.

shaded row indicates recommended values for Yosemite Slough.

**Abbreviations:**

kg = kilograms

kg/day = kilograms per day

dw = dry weight

mg/kg/day = milligrams per kilogram per day

BAF = bioaccumulation factor

SUF = site use factor

TRV = toxicity reference value

NOAEL = no observed adverse effect level

LOAEL = lowest observed adverse effect level

HQ = hazard quotient

PCB = polychlorinated biphenyls

RBC = risk-based concentration

**Table 4. Exposure Parameters for the California Clapper Rail (*Rallus longirostris obsoletus*) from HAA**

Parameter	Symbol	Value	Unit	Reference
Food Ingestion Rate	IR <sub>food</sub>	0.033	kg/day (dw)	Calculated using body weight of 390 g with equation for food requirement for intake for omnivorous birds (Nagy 2001): $[[0.67*(BW)]^{0.627}]/1000$
Sediment Ingestion Rate	IR <sub>sed</sub>	0.0059	kg/day (dw)	18% of food ingestion rate; based on value for least sandpiper (Beyer et al. 1994)
Dietary Composition	% diet	100% 0%	invertebrates plants	Assumption used in US Army (2001)
Home Range	-	31	acres	Mean home range of the clapper rail in Arizona during breeding season (Conway et al. 1995) as referenced by OEHHA (2012)
Site Use Factor	SUF	0.3	unitless	Assumes entire slough area is used for foraging ~10 acres
Body Weight	BW	0.39	kg	Mean values for the clapper rail from Albertson (1995) as referenced in US Army (2001)
Toxicity Reference Value - low	TRV <sub>low</sub>	0.09	mg/kg/day	From Platonow & Reinhart (1973) as referenced by Region 9 BTAG (DTSC 2009); based on chicken (BW = 0.8 kg)
Toxicity Reference Value - high	TRV <sub>high</sub>	1.27	mg/kg/day	From Britton & Huston (1973) as referenced by Region 9 BTAG (DTSC 2009); based on chicken (BW = 1.72 kg)
Body Weight Adjusted TRV - low	Adjusted TRV <sub>low</sub>	0.078	mg/kg/day	Body-weight adjusted TRV (Sample and Arenal 1999)
Body Weight Adjusted TRV - high	Adjusted TRV <sub>high</sub>	0.944	mg/kg/day	

**Note:** Values in red were obtained from US Army (2001) Final Human Health and Ecological Risk Assessment at the Hamilton Army Airfield (HAA), BRAC property in Novato, CA.

**Abbreviations:**

kg = kilograms  
kg/day = kilograms per day  
g = gram  
dw = dry weight  
mg/kg/day = milligrams per kilogram per day  
IR = ingestion rate  
BW = body weight  
BAF = bioaccumulation factor  
SUF = site use factor  
TRV = toxicity reference value  
HAA = Hamilton Army Airfield

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Table 5a. NOAEL-Based RBCs for California Clapper Rail - PCBs (scaled TRVs and HAA Exposure Parameters)

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				NOAEL	NOAEL	
0.39	1	0.000	2	0%	100%	0.000	0.852	0.0328	0.0059	0.08	0.078	0.43	1.00
0.39	0.9	0.000	2	0%	100%	0.000	0.946	0.0328	0.0059	0.08	0.078	0.47	1.00
0.39	0.8	0.000	2	0%	100%	0.000	1.064	0.0328	0.0059	0.08	0.078	0.53	1.00
0.39	0.7	0.000	2	0%	100%	0.000	1.216	0.0328	0.0059	0.08	0.078	0.61	1.00
0.39	0.6	0.000	2	0%	100%	0.000	1.419	0.0328	0.0059	0.08	0.078	0.71	1.00
0.39	0.5	0.000	2	0%	100%	0.000	1.703	0.0328	0.0059	0.08	0.078	0.85	1.00
0.39	0.4	0.000	2	0%	100%	0.000	2.129	0.0328	0.0059	0.08	0.078	1.06	1.00
0.39	0.3	0.000	2	0%	100%	0.000	2.838	0.0328	0.0059	0.08	0.078	1.42	1.00
0.39	0.2	0.000	2	0%	100%	0.000	4.258	0.0328	0.0059	0.08	0.078	2.13	1.00
0.39	0.1	0.000	2	0%	100%	0.000	8.515	0.0328	0.0059	0.08	0.078	4.26	1.00
0.39	0.05	0.000	2	0%	100%	0.000	17.030	0.0328	0.0059	0.08	0.078	8.52	1.00
0.39	0.02	0.000	2	0%	100%	0.000	42.575	0.0328	0.0059	0.08	0.078	21.29	1.00
0.39	0.01	0.000	2	0%	100%	0.000	85.150	0.0328	0.0059	0.08	0.078	42.58	1.00

Table 5b. LOAEL-Based RBCs for California Clapper Rail - PCBs (scaled TRVs and HAA Exposure Parameters)

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				LOAEL	LOAEL	
0.39	1	0.000	2	0%	100%	0.000	10.3	0.0328	0.0059	0.94	0.944	5.13	1.00
0.39	0.9	0.000	2	0%	100%	0.000	11.4	0.0328	0.0059	0.94	0.944	5.70	1.00
0.39	0.8	0.000	2	0%	100%	0.000	12.8	0.0328	0.0059	0.94	0.944	6.41	1.00
0.39	0.7	0.000	2	0%	100%	0.000	14.7	0.0328	0.0059	0.94	0.944	7.33	1.00
0.39	0.6	0.000	2	0%	100%	0.000	17.1	0.0328	0.0059	0.94	0.944	8.55	1.00
0.39	0.5	0.000	2	0%	100%	0.000	20.5	0.0328	0.0059	0.94	0.944	10.26	1.00
0.39	0.4	0.000	2	0%	100%	0.000	25.6	0.0328	0.0059	0.94	0.944	12.82	1.00
0.39	0.3	0.000	2	0%	100%	0.000	34.2	0.0328	0.0059	0.94	0.944	17.09	1.00
0.39	0.2	0.000	2	0%	100%	0.000	51.3	0.0328	0.0059	0.94	0.944	25.64	1.00
0.39	0.1	0.000	2	0%	100%	0.000	102.6	0.0328	0.0059	0.94	0.944	51.28	1.00
0.39	0.05	0.000	2	0%	100%	0.000	205.1	0.0328	0.0059	0.94	0.944	102.55	1.00
0.39	0.02	0.000	2	0%	100%	0.000	512.8	0.0328	0.0059	0.94	0.944	256.38	1.00
0.39	0.01	0.000	2	0%	100%	0.000	1025.5	0.0328	0.0059	0.94	0.944	512.77	1.00

Notes:

Following inputs to the dietary dose model and the TRV, goal seek was used to calculate a RBC based on an HQ of 1.

shaded row could be considered for Yosemite Slough.

Abbreviations:

kg = kilograms

kg/day = kilograms per day

dw = dry weight

mg/kg/day = milligrams per kilogram per day

BAF = bioaccumulation factor; diet was assumed to be 100% invertebrates and 0% plants

SUF = site use factor

TRV = toxicity reference value

NOAEL = no observed adverse effect level

LOAEL = lowest observed adverse effect level

HQ = hazard quotient

HAA = Hamilton Army Airfield

PCB = polychlorinated biphenyls

RBC = risk-based concentration

Table 6a. NOAEL-Based RBCs for California Clapper Rail - PCBs (unscaled TRVs and HAA Exposure Parameters)

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				NOAEL	NOAEL	
0.39	1	0.000	2	0%	100%	0.000	0.983	0.0328	0.0059	0.09	0.09	0.49	1.00
0.39	0.9	0.000	2	0%	100%	0.000	1.092	0.0328	0.0059	0.09	0.09	0.55	1.00
0.39	0.8	0.000	2	0%	100%	0.000	1.228	0.0328	0.0059	0.09	0.09	0.61	1.00
0.39	0.7	0.000	2	0%	100%	0.000	1.404	0.0328	0.0059	0.09	0.09	0.70	1.00
0.39	0.6	0.000	2	0%	100%	0.000	1.638	0.0328	0.0059	0.09	0.09	0.82	1.00
0.39	0.5	0.000	2	0%	100%	0.000	1.965	0.0328	0.0059	0.09	0.09	0.98	1.00
0.39	0.4	0.000	2	0%	100%	0.000	2.456	0.0328	0.0059	0.09	0.09	1.23	1.00
0.39	0.3	0.000	2	0%	100%	0.000	3.275	0.0328	0.0059	0.09	0.09	1.64	1.00
0.39	0.2	0.000	2	0%	100%	0.000	4.913	0.0328	0.0059	0.09	0.09	2.46	1.00
0.39	0.1	0.000	2	0%	100%	0.000	9.825	0.0328	0.0059	0.09	0.09	4.91	1.00
0.39	0.05	0.000	2	0%	100%	0.000	19.650	0.0328	0.0059	0.09	0.09	9.83	1.00
0.39	0.02	0.000	2	0%	100%	0.000	49.125	0.0328	0.0059	0.09	0.09	24.56	1.00
0.39	0.01	0.000	2	0%	100%	0.000	98.250	0.0328	0.0059	0.09	0.09	49.13	1.00

Table 6b. LOAEL-Based RBCs for California Clapper Rail - PCBs (unscaled TRVs and HAA Exposure Parameters)

Body Weight (kg)	SUF	BAF		Dietary Composition (%)		Tissue Concentrations (mg/kg)		Daily Ingestion Rate (kg/day dw)	Sediment Ingestion Rate (kg/day dw)	Dietary Dose (mg/kg/day)	TRV (mg/kg/day)	RBC (mg/kg)	HQ
		Plants	Inverts	Plants	Inverts	Plants	Inverts				LOAEL	LOAEL	
0.39	1	0.000	2	0%	100%	0.000	13.9	0.0328	0.0059	1.27	1.27	6.93	1.00
0.39	0.9	0.000	2	0%	100%	0.000	15.4	0.0328	0.0059	1.27	1.27	7.70	1.00
0.39	0.8	0.000	2	0%	100%	0.000	17.3	0.0328	0.0059	1.27	1.27	8.67	1.00
0.39	0.7	0.000	2	0%	100%	0.000	19.8	0.0328	0.0059	1.27	1.27	9.90	1.00
0.39	0.6	0.000	2	0%	100%	0.000	23.1	0.0328	0.0059	1.27	1.27	11.55	1.00
0.39	0.5	0.000	2	0%	100%	0.000	27.7	0.0328	0.0059	1.27	1.27	13.86	1.00
0.39	0.4	0.000	2	0%	100%	0.000	34.7	0.0328	0.0059	1.27	1.27	17.33	1.00
0.39	0.3	0.000	2	0%	100%	0.000	46.2	0.0328	0.0059	1.27	1.27	23.11	1.00
0.39	0.2	0.000	2	0%	100%	0.000	69.3	0.0328	0.0059	1.27	1.27	34.66	1.00
0.39	0.1	0.000	2	0%	100%	0.000	138.6	0.0328	0.0059	1.27	1.27	69.32	1.00
0.39	0.05	0.000	2	0%	100%	0.000	277.3	0.0328	0.0059	1.27	1.27	138.64	1.00
0.39	0.02	0.000	2	0%	100%	0.000	693.2	0.0328	0.0059	1.27	1.27	346.61	1.00
0.39	0.01	0.000	2	0%	100%	0.000	1386.4	0.0328	0.0059	1.27	1.27	693.21	1.00

**Notes:**  
Following inputs to the dietary dose model and the TRV, goal seek was used to calculate a RBC based on an HQ of 1.  
shaded row could be considered for Yosemite Slough.

**Abbreviations:**  
kg = kilograms  
kg/day = kilograms per day  
dw = dry weight  
mg/kg/day = milligrams per kilogram per day  
BAF = bioaccumulation factor; diet was assumed to be 100% invertebrates and 0% plants  
SUF = site use factor  
TRV = toxicity reference value  
NOAEL = no observed adverse effect level  
LOAEL = lowest observed adverse effect level  
HQ = hazard quotient  
HAA = Hamilton Army Airfield  
PCB = polychlorinated biphenyls  
RBC = risk-based concentration